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Digital Generation Pre-Service Teachers as Change Agents: a Paradox

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Turkish Pre-Service Teachers' Beliefs About The Importance Of Teaching Chemistry

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Abstract: The purpose of this study was to describe Turkish pre-service chemistry teachers' beliefs about the importance of teaching chemistry in high schools. For this purpose, 45 pre-service chemistry teachers were administered a questionnaire involving open-ended questions which asked what the importance of teaching chemistry is, and why we teach chemistry in high schools. Based on the written responses, 12 pre-service teachers were chosen to be interviewed to obtain more elaborated information about their beliefs. Data analysis revealed that most of the pre-service teachers expressed that chemistry should be taught in order to explain daily life events. However, a very small number of them believed that teaching chemistry was important in terms of developing generic skills like critical thinking, and of creating curiosity and interest. This study suggests that chemistry should be taught both in high schools and universities in a way which emphasizes the importance of developing scientific skills.

Introduction

The present study aims to find out Turkish pre-service chemistry teachers' beliefs about the importance of teaching chemistry in high schools. Beliefs have been considered to be an important psychological construct to teacher education (Pintrich, 1990). When pre-service science teachers come to universities, they bring many beliefs about science teaching/learning. These beliefs may result from their experiences as a student in their schooling period. (Briscoe, 1991; Gunstone, Slattery, Bair & Northfield, 1993; Wallace & Louden, 1992; Tsai, 2002). Similarly, pre-service teachers' experiences in the university through the science classes, laboratory exercises, and relevant activities are also influential to develop their beliefs about science teaching/learning. Nespor (1987) claims that remembered stories and events, affective elements such as feelings about teachers, subjective evaluations and existential presumptions make up the belief system of people.

Existing beliefs of pre-service teachers should be considered in the teacher education programs since these beliefs interact with their learning. Such beliefs influence pre-service teachers interpretation of pedagogical knowledge, conceptualization of teaching tasks, their teaching decisions and their classroom practice (King, Shumow & Lietz, 2001; Pajares, 1992; Bryan, 2003; Veal, 2004). Therefore, in teacher education programs it is important to identify prospective teachers' beliefs about teaching and learning and encourage them to reflect upon these beliefs (Mellado, 1998; Southerland & Gess-Newsome, 1999). The present study aims to describe Turkish pre-service chemistry teachers' beliefs about why to teach chemistry in high schools.

Literature Review

This section of the study summarizes related literature on the definition of beliefs, a distinction between belief and knowledge, the importance of teachers' beliefs in teaching and the studies on pre-service teachers' beliefs about teaching, under the framework of the purposes of science education.

Fishbein and Ajzen (1975) define beliefs as information, factual and nonfactual cognitions. Cognition is described as "what someone knows or assumes to be true" (Berkowitz, 1980, p. 275). Beliefs can be descriptive, inferential or informational. Descriptive beliefs can be observed directly. The sentence "Science is knowledge" is an example of descriptive beliefs. Although inferential beliefs cannot be directly observed, they can be based on prior descriptive beliefs. For example, if someone has descriptive beliefs that "Science is knowledge" and "Knowledge is important", then he has inferential belief that "Science is important". Informational beliefs can rise from knowledge whose source is outside such as newspapers or TV (Shrigley, Koballa & Simpson, 1988). Beliefs differ from knowledge, although they are related to each other, in that beliefs do not always represent the truth. On the other hand, beliefs include understandings, assumptions, images or propositions that are felt to be true (Richardson, 1996; Kagan, 1992). Beliefs are considered as discipline-dependent (Tsai, 2002). Nespor (1987) also states that a belief system includes groups of beliefs that do not need to have general consensus. Beliefs in a system are consistent with each other unless they are examined against each other (Green, 1971).

In the related literature, there has been a discussion on the terms knowledge and beliefs among philosophers, educational psychologists, and science educators. From a philosophical perspective, belief is a necessary, however, not a sufficient condition for knowledge. Knowledge is objective, rational, public, and verified whereas belief is more subjective, irrational, personal, and unverified (Smith & Siegel, 2004). Educational psychologists do not offer a clear distinction between knowledge and belief stating that belief is a "particularly slippery term in the psychological literature" (Hofer & Pintrich, 1997, p.112). Science educators view knowledge as "evidential, dynamic, emotionally-neutral" whereas belief is described as "both evidential and non-evidential, static, emotionally-bound" (Gess-Newsome, 1999, p.55). Because of being central to understanding the nature of science, knowledge and belief is important in science classrooms. Therefore, science teachers should find out what beliefs students have. However, the primary purpose of science education should be to foster students' knowledge and understanding of the content, process and nature of science, instead of their beliefs. Belief will generally follow understanding, however, in some situations, this does not occur (Smith & Siegel, 2004). In this study, belief about teaching chemistry is described as a descriptive thought that a person holds about chemistry and chemistry teaching.

Teachers' beliefs about students, learning, the nature of science and science education, epistemology, curriculum, students and parents' expectations and the role of teacher affect the way that science teachers teach (Wallace & Kang, 2004; Wellington, 2000). Salmon (1988) states that teachers' beliefs about the importance of science teaching have a great impact on their teaching practices. Therefore, several research studies have been carried out in order to describe teachers' beliefs about science and science teaching (Aguirre, Haggorty & Linder, 1990; Hashweh, 1996; Pomeroy, 1993; Smith & Neale, 1991; Spear, 1984; Levitt, 2001; Tsai, 2002; Bryan, 2003; Porlán & Martín del Pozo, 2004). Other studies found out that there was a relationship between beliefs and teaching practices. (Tobin & Espinet, 1989; Mitchener & Anderson, 1989; Cronin-Jones, 1991; Dillon, O'brien, Moje & Stewart, 1994; Richardson, 1996; Hashweh, 1996; Bryan & Abell, 1999; Bryan, 2003; Veal, 2004; Waters-Adams, 2006). Pajares (1992) supports this statement by indicating the beliefs to be the best indicators of the decisions individuals make throughout their lives.

In order to investigate and understand teachers' beliefs about science education, it is important to know the purposes of science education stated by the literature. According to Millar and Osborne (1998), the purposes of science education are:

- Developing curiosity of students about the natural world and confidence in their ability to investigate the natural world.
- Creating interest and enthusiasm in science to engage with scientific matters.
- Helping students acquire scientific knowledge and understand scientific inquiry so that they can understand the underlying rationale for decisions (for example about diet, medical treatment or energy use)
- Helping students to be able to understand and critically evaluate media reports related to science
- Helping students hold and express a personal point of view about scientific issues, which enter the arena of public debate.
- Attaining further knowledge either for interest or vocational purposes.

In addition to the above purposes, one of the aims of science education is to develop generic skills such as measuring accurately, handling apparatus, evaluating, critical thinking skills, which are valuable in our daily lives (AAAS, 1991; Parkinson, 1994; Ratcliffe, 1998; Wellington, 2000; Chiappetta & Koballa, 2002). By the 1990s, term scientific literacy has been introduced as a purpose of science education (AAAS, 1997; Chiappetta & Koballa, 2002). It can be understood from these purposes that science education should foster both cognitive and psychomotor elements as well as the affective domain. To illustrate, science education should promote students' understanding of scientific phenomena and inquiry and foster critical thinking skills, which are related to cognitive domain. Science education should help students develop manipulative skills such as handling apparatus or measuring accurately, which are involved in the psychomotor aspect. Affective domain of science education involves the development of pupils' interest, curiosity, motivation and enthusiasm towards science.

Based on this literature, the purpose of this study was to determine Turkish pre-service chemistry teachers' beliefs about the importance of chemistry and chemistry teaching. The research questions are:

1. What are the Turkish pre-service chemistry teachers' beliefs about the importance of chemistry and chemistry teaching in high schools?
2. What are the underlying factors that lead to these beliefs in Turkish pre-service chemistry teachers?

Methodology

Participants

To address these research questions, data were collected from 45 Turkish pre-service chemistry teachers attending a university in Turkey. Of 45 students, 19 were male and 26 were female. Students' age ranged from 21 to 24. They were either in the fourth or fifth class students.

In Turkey, all high school graduates should pass a centralized nation-wide examination in order to attend a university. This exam consists of multiple-choice questions that measure verbal and numerical ability, Turkish language, mathematics, physics, chemistry, biology, history, and geography achievements. The final score is calculated by considering the score taken from this exam and the high school grade-point averages and this score is the determining factor for admission to a university (YÖK, 2000). The university in this sample accepts students who achieve a higher score on the University Entrance Exam than other Turkish universities do. The participants enrolled in the Faculty of Education in this

university follow a five-year integrated program. In order to complete an integrated program, a student must take chemistry classes in the first seven semesters from the Department of Chemistry of the Faculty of Arts and Sciences. After completing these classes, in the remaining three semesters, he/she must take the courses related to the teaching profession from the departments of Educational Sciences and Secondary Science and Mathematics Education. The students are granted a M.S. degree without thesis upon graduation. The graduates of the Department are employed by the Ministry of Education and private schools as chemistry teachers.

In this study, most of the pre-service teachers have taken educational courses such as Introduction to Teaching Profession, Development and Learning, Instructional Planning and Evaluation in Secondary Education, Methods of Science Teaching and School Experience in Secondary Education in the last semester.

Data Collection Methods

The data were collected in the first semester of 2004-2005 academic year from pre-service chemistry teachers by means of two instruments, the open-ended questionnaire and a semi-structured interview as a follow-up study.

Questionnaire

In a class time of 50 minutes, participants wrote about the following questions, prepared by the researchers in accordance with research questions and related literature: 'In your opinion, what is the importance of chemistry and chemistry teaching?'; 'What is the aim of chemistry teaching?' and 'Why do we teach chemistry in high schools? These three questions assess the same issue; they were asked in order to get access to pre-service teachers` thinking about the importance of chemistry teaching in high schools.

Interviews

In addition to pre-service teachers' written responses, semi-structured interviews were carried out with twelve pre-service teachers selected according to their written responses which reflected different perspectives. The main criteria for choosing interviewees were based on the exploration of as many different views and interesting answers as possible given in the questionnaire. The aim of the interview was to obtain a more elaborated source of data on their beliefs about importance of chemistry and chemistry teaching. In addition, some of the responses given in the questionnaire weren't clear due to either incomplete explanations or ambiguity. They needed further probing. For this reason, interview questions were prepared by considering the pre-service teachers' written responses and during the interviews, some questions were added. Elapsed time between the questionnaires completed by pre-service chemistry teachers and the interviews was approximately two to three weeks. All the interviews lasted about 30 minutes. Each interview was audio taped and transcribed.

Analysis

As Flick (1998) states, the choice of a research question determines the research design and the methods used to collect and interpret data. General, comprehensive and flexible,

rather than precise, research questions should be formulated for qualitative research. Precise questions put into the form of a hypothesis tend to be applicable, mainly, in a quantitative study (Robson, 1993). Since research questions in this study are general and reflect the intention of finding out the beliefs of prospective teachers' about the importance of chemistry teaching, the qualitative approach was used. The analysis of pre-service teachers' written responses was based on forming general categories and sub-categories under general categories according to their responses showing their beliefs about the importance of chemistry and chemistry teaching. The process of categorization involved searching evidence and sorting descriptive data to represent regularities and patterns (Bogdan & Biklen, 1998).

In this study, first, pre-service teachers' written responses were examined by the researchers independently. Then, the researchers came together and decided final form of coding categories such as daily life, developing generic skills, improving scientific literacy and others. Next, each researcher worked individually in order to group these coding categories under three main categories as *intrinsic value*, *utilitarian* and *citizenship arguments*, suggested by Wellington (2000). These categories were compared and final form of categories was constructed.

Intrinsic Value

This category includes pre-service teachers' responses mentioning the importance of chemistry and chemistry teaching as helping us make sense of the universe and ourselves. For example, in our daily lives or on TV, we see condensation, frost, dew, obesity, orbiting comets and etc, all of which can be explained by science. Pre-service teachers with this belief indicate that chemistry and chemistry teaching help students understand about the world and themselves.

Utilitarian Arguments

This category involves pre-service teachers' beliefs indicating the importance of chemistry teaching as developing certain, general skills, which are transferable to other situations and valuable in people's daily lives. For example, science teaching helps children develop critical thinking skills necessary to sort through all the "information" that they will encounter in their lives. In addition, science teaching helps students develop manipulative skills such as handling the equipment, using a range of instruments. Moreover, this category involves responses of pre-service teachers, who believe that chemistry teaching is important in terms of developing students' attitudes, curiosity, and interest towards chemistry. This category also describes teachers' responses, which explain the importance of chemistry teaching in preparing some students for future career and jobs involving science.

Citizenship Arguments

This category includes responses of pre-service teachers that indicate that chemistry teaching is important in helping students understand the nature of science, scientific knowledge, and knowledge of scientists' work in order for them to make decisions and acquire further understanding of society and environment.

Validity and Reliability

The analysis of the pre-service chemistry teachers' written responses indicated that questions in the questionnaire measured what they were supposed to measure. To measure the reliability of these questions, since data in this study is nominal, the inter-rater reliability was calculated (Bryman & Cramer, 1997). This was used to assess the degree of agreement between the categorizations of two independent coders. Inter-rater reliability coefficient was found as 0.856. This value indicates high level of agreement.

Results

According to the written responses to the questions asking what the importance of chemistry and chemistry teaching are and why we teach chemistry in high schools, three main categories and sub-categories under these main categories were constructed. It should be noted that some of the prospective teachers' written responses were put into more than one category since they involved some elements that belong to other categories. In addition, in one case, during the interviews, the pre-service teacher gave additional explanations related to other categories which she/he did not mention in the written responses. Table 1 shows the frequency and percentages of pre-service teachers for each category of beliefs, based on pre-service teachers' written responses.

Beliefs	Frequency of pre-service teachers	Percentages of pre-service teachers' (%)
Intrinsic value		
Daily life		
Understand nature and life (body, food, clothing)	30	66.6
Industry (medicine, cleaning)	8	17.7
Make life easy	4	8.88
Utilitarian arguments		
Developing generic skills	5	11.11
Educating the future chemists	3	6.66
Developing curiosity and interest in chemistry	1	2.22
Form the base for other sciences	6	13.3
Citizenship arguments		
Improving scientific literacy	3	6.66

Table 1: Pre-service chemistry teachers' views of chemistry teaching

Intrinsic Value

Daily Life

As it can be seen from table 1, 66.6% of the pre-service teachers considered the importance of chemistry teaching in terms of intrinsic value. This is the highest percentage in all three categories. Most of the participants believed that chemistry was important in terms of understanding daily life. Understanding daily life includes understanding natural events, our body, contents of foods, and materials used for clothing, cleaning and medicine. Also, some participants stated that chemistry makes our lives easy, for this reason it is important. One of the participants in the interview said that:

> Chemistry is closely related to daily life. We can encounter the reactions we observed in laboratories in nature. The properties of water we use everyday are explained by chemistry. The air we breathe contains gases. Also, there is chemistry in our body. For example, our stomach is acidic. From clothing to foods, everything involves chemistry. Therefore, it is important to teach.

Other pre-service teachers stated the use of chemistry in the kitchen. For example, one of them explained during the interview:

> We can use chemistry in our daily life. For example, gas pressure or pressure cookers… We can use chemistry in many areas. Chemistry is a science that can be applied to daily life easily, for this reason it is important to teach.

In considering daily life events, most of the pre-service teachers gave examples of foods or body. However, some pre-service teachers mentioned about the importance of chemistry in industry. One of them gave the following explanations in the interview:

> Researcher (R): In your opinion, what is the importance of chemistry teaching in high schools?
>
> Pre-service Teacher (T): Students should use chemistry to express how the world occurred, to internalize life…and to understand that chemistry is a useful science.
>
> R: Why is it useful?
>
> T: I don't know, it is used in every area, such as industry…Chemistry should be taught in order to understand daily life.

In addition, some pre-service teachers had beliefs that chemistry makes life easy. One of them gave the following explanations during the interviews:

> ….Pressure cookers decrease cooking time of foods so we can cook quickly. In winters, we pour salt to the roads in order to decrease the freezing point. So, chemistry makes our lives easy. Therefore, chemistry is important.

Moreover, some pre-service teachers stressed the importance of chemistry teaching by stating chemistry as an inevitable part of life:

> We are not aware of the events of daily life, we live but most of us are not aware of life. So, to understand the details of life, to make connections, and to integrate course and life, we should teach chemistry……..We should make students understand that chemistry is not apart from our lives, we should not teach chemistry just as a course; we should explain students that chemistry is a part of our lives.

Generally, all of the pre-service teachers give value to chemistry and chemistry teaching since life rests on chemistry. Pre-service teachers agree that people should explain daily life events scientifically by means of chemistry. For this reason, chemistry should be taught.

Utilitarian Arguments

Generic Skills

In the questionnaires, a few pre-service teachers mentioned that chemistry teaching was important in order to improve scientific skills such as interpretation, critical thinking skills and others. In the interviews, the pre-service chemistry teacher who wrote that the aim of chemistry teaching was to improve interpretation skills gave the below explanations:

> R: You wrote that chemistry teaching should improve the interpretation skills of students. Can you explain it more?
>
> T: For example, as a chemistry teacher, I cannot teach all of the things related to chemistry. There will not be a chemistry teacher around when a student finishes school. Therefore, it is important to

> teach the interpretation skills. A student can be able to interpret and learn chemistry by him/her self.

The above quote indicates that the pre-service chemistry teacher believed that one of the aims of chemistry teaching should be to develop students' interpretation skills.

Another pre-service teacher who mentioned as a written response the importance of chemistry teaching in terms of both explaining daily life events and developing thinking skills gave the following explanations during the interview:

> T:……On the other hand, there may be things we could not apply directly to daily life; in that case we can use chemistry to develop our mind by developing our thinking ability. From this point of view chemistry is important both for explaining daily life events and developing thinking skills.
>
> R: How does chemistry develop thinking?
>
> T: For example, you analyze something. You examine small parts. If you improve this ability, you can behave in your daily life with respect to this; I mean you can plan your works and finish them fast.
>
> R: So, you mean that if we learn to analyze in chemistry, we can use this in our daily life in any problem, whether it is related to chemistry or not does not matter.
>
> T: Yes. Or, just the opposite, synthesize…From this point of view, chemistry is also important.

This pre-service teacher both mentioned the importance of chemistry in explaining daily life events and highlighted the use of analyzing and synthesizing in all kind of problems. Chemistry is the science that utilizes these processes. In chemistry, students learn to analyze and synthesize and use these skills in their life. From this point of view, chemistry teaches not only knowledge but also how to think. It develops thinking skills. Similarly, another interviewed pre-service teacher said that:

> "Chemistry is necessary to analyze things around us. Actually, we could not say only things or matter; it is also necessary to analyze events. We should see specific parts when we look at generally or we should foresight the whole by combining parts. In short, we learn to analyze and synthesize while we are learning chemistry concepts. We can apply the skills we acquire in the laboratory in real life. Laboratory work provides systematic study, which means studying hard and step by step to accomplish a task. So students can apply this in their life."

This pre-service teacher also believed that chemistry teaching is important but she also considered laboratory particularly. In her opinion, laboratory work is a part of chemistry education and laboratory is the place where analysis and synthesis are learned. Another interviewed pre-service teacher also mentioned about laboratories. He said that laboratory develops analytical thinking ability therefore chemistry should be taught.

Another pre-service teacher added that chemistry develops critical thinking ability; students learn to make observations, state cause-effect relationship, and evaluate events in chemistry classes. Therefore, chemistry should be taught.

Future Chemists

Both in the questionnaire and interviews, some pre-service teachers stated that teaching chemistry in high school was important for students since they may decide to have a career in chemistry. According to one interviewed pre-service teacher, chemistry education in high schools is necessary for further education in universities. It prepares students to university level chemistry. Students at the high school learn basic principles and use these in their future study.

Some pre-service teachers who stated in the questionnaire that chemistry teaching was important for educating future chemists also added that most professions needed chemistry like medicine, pharmacy or engineering. They stressed that not only chemistry but also other sciences, physics or biology, were necessary and should be taught. Their written responses were included in both "Educating the Future Chemists" and "Form the Base for other Sciences" subcategories.

Base for other sciences

Pre-service teachers mentioned that chemistry was related to physics, biology or mathematics and they are all interrelated. Therefore, all students should learn these topics and use concepts transversally. One interviewed pre-service teacher states that:

> All branches of science are related to each other. You cannot separate one from others. For example, let's think of biology. You can explain reactions in the organisms by help of chemistry. Chemistry should be taught in order to understand these reactions covered in biology.

Another pre-service teacher mentioned in the interviews: "Students should be taught that science is a collection of chemistry, biology, physics, and even mathematics. Therefore, students should learn chemistry to understand other sciences"

Interest in science

In the interviews, two pre-service teachers told that chemistry teaching was important in terms of developing interest in chemistry although only one pre-service teacher stated this category in the questionnaire. In the interviews, one pre-service teacher mentioned that:

> …Another purpose of chemistry teaching is to increase interest in chemistry. In order to teach chemistry, you should make students enjoy chemistry. Students will conduct research related to chemistry topics and become successful in the class if they like it. Therefore, as a teacher, you should get students to like chemistry….

Another pre-service teacher's explanations in the interview are:

> R: What is the importance of chemistry teaching in high schools?
>
> T: In my opinion, making students like chemistry is more important than teaching chemistry because when students like chemistry, they will learn. Therefore, as teachers our aim should be to make students like chemistry.
>
> R: Why is it important to have students like chemistry?
>
> T: …They may be eager to learn chemistry if they like chemistry.

This student believes that chemistry should be taught in order to develop interest in chemistry. She also mentioned that if students like chemistry, this helps students learn

chemistry. This student's further explanations to this question, in both the questionnaire and interview were also related to another category called "importance for scientific literacy" since she added that students should like chemistry to be more sensitive to the environment: "Students become more sensitive to the environment. They use detergents or bleach more carefully. "

Citizenship Arguments

Scientific Literacy

Scientific literacy means understanding the nature of science, scientific knowledge, relationship between concepts, laws, theories, and relations between science and society and environment, and using the process of science in solving problems, making decisions and further understanding of society and environment (Explanations of the Factors, n.d.).

Although this category is related to daily life subcategory, it differs from it since it connects the importance of teaching chemistry more to the scientific approach. For this reason, it was separated from daily life subcategory.

Another pre-service teacher who, in the questionnaire, justified the importance of chemistry as both in terms of explaining daily life and scientific literacy gave the following explanations in the interview:

> …..Chemistry is important in terms of daily life. People should have knowledge about the products they bought. For example, there are many additives in many foods. People should understand what they are. In some foods, there may be additives harmful to health. People should be conscious of them…Another example is coke. It contains caffeine large amount of which may be harmful and therefore people should drink it in a limited amount. This awareness can be raised by the help of chemistry. For this reason, it should be taught.

Another striking answer was that:

> ….We should learn chemistry because we have to understand and interpret the matters and events around us. As a branch of science, we have to learn chemistry. By saying learning chemistry, I mean that learning scientific thinking and develop a scientific framework for explaining events. As teachers, we should teach students how to use science in a real situation when they are on their own. Chemistry teaching is important to teach scientific thinking…

These pre-service teachers believed that chemistry is important as a way of thinking. Chemistry develops scientific thinking and students use this in their daily life. There won't be teachers always explaining concepts, therefore, students should understand and interpret events by themselves. Scientifically literate people apply their scientific knowledge in explaining and analyzing issues. From this point of view, chemistry is a mean for promoting scientific literacy.

During interviews, researchers expanded the conversation by asking an additional question, not included in the questionnaire: should all students learn chemistry at the high school? The fact that some pre-service teachers said that students should learn chemistry because they may wish to have a career in chemistry, or because they may be interested in chemistry directed the researchers to ask this question. Most of the pre-service teachers answered that all students should be taught chemistry at the high school since it is necessary for explaining life. This shows that pre-service teachers give priority to the reason chemistry explains daily life events. The researchers also investigated reasons for these beliefs. Most of the pre-service teachers used their own school experiences either in high school or university while answering questions. For example:

> While I was at high school, our chemistry teacher presented chemistry topics as if they were from a different world, I mean, he did not give any example from our lives. But, last week I went to high school where I work as a student teacher and observed a chemistry class. The teacher talked about tea or coffee while introducing solutions. He mentioned about jam. So, chemistry explains life and therefore students should learn chemistry and teachers should emphasize daily life examples.

The same pre-service teacher also stated that

> Giving daily life examples also cause longer retention. For example, our instructor teaching organic chemistry gave usage TNT and explained formula etc. So I can easily remember it when I know its usage. If our instructor just wrote the formula, I would not remember it easily.

Another pre-service teacher was asked:

> R: …So you think that chemistry should be taught to explain daily life events and to develop analytical thinking ability. What are the reasons of your thoughts? Why do you think like that?
>
> T: ..Because of the education here (university)
>
> R: Didn't you think like that during high school?
>
> T: No, I don't think that I learned chemistry in the high school.
>
> R: Then, at the university, which classes drove you to think like that, chemistry classes or pedagogical classes?
>
> T: Chemistry classes.

The above explanations of prospective teachers indicate that their experiences in the chemistry class as a student both in the high school and university were influential to hold such beliefs about the importance of chemistry teaching.

Discussion

The findings of this study indicate that most of the pre-service teachers believed firstly that chemistry teaching is important in high schools in order to understand daily life. The percentage of pre-service teachers' answers for this category (about 84%) was the highest by far in all categories. According to these pre-service teachers, their students should learn how to explain scientifically the events they are faced with in their life, by using their school chemistry. They gave many examples most of which were related to kitchen chemistry. For example, they mentioned that, in relation to cooking pasta, students should explain why they add salt to water after the water boiled or why they use pressure cookers. In addition, pre-service teachers gave examples of cleaning agents. They claimed that students should know the contents of them so that they become conscious customers. If a person knows the content, she/he may use the correct cleaner for surfaces. People should also have knowledge about the contents of medicine. In this way, they can know the reason for using it and understand how it works. Chemistry allows people to comprehend all of these things which are the parts of daily life. Therefore, chemistry teaching is important. The reason for the highest percentage of answers in this category may be the fact that pre-service teachers want their students to perceive chemistry not as a compulsory class but mainly as a science explaining routine things they do in everyday life.

Secondly, chemistry teaching is important in high schools since it is related to other areas such as physics, biology and mathematics. Most of the pre-service teachers thought that science should be perceived as a whole without separating chemistry, physics, biology

and mathematics. Also, many concepts from different areas are related to each other, for example, the concept of energy is a part of both physics and chemistry; the reactions in biology can be explained by using chemistry. As a result, pre-service teachers thought that in order to understand other science topics and be successful in other science classes, chemistry should be taught.

Thirdly, pre-service teachers participated in the study believed that chemistry teaching was important in high schools in order to develop generic skills. By saying thinking skills, they mean analytical thinking skills mostly. They emphasized to use synthesis and analysis when encountering a problem. Chemistry provides these skills especially in laboratories. Chemistry develops students' way of thinking in a way that they use scientific method. Then, they can use these thinking abilities they gained in the chemistry class in any problem in their life. Also, students' critical thinking ability can be improved by chemistry. For this reasons, chemistry should be taught. Pre-service teachers stating this category give importance to cognitive abilities. Their laboratory sessions may have caused pre-service teachers to hold this belief since most of the pre-service teachers gave examples from their laboratory classes.

Fourthly, pre-service teachers believed that chemistry teaching is important in high schools for educating future chemists. They thought that students may think chemistry as a profession, thus, they should learn chemistry. Chemistry that was studied at the high school may affect students' career decision. For this reason, chemistry should be learned in high schools.

Fifthly, chemistry teaching is important in high schools for scientific literacy. People should understand the nature of science and integrate scientific principles and the society and environment. Educating scientifically literate citizens should be one of the purposes of chemistry education in high schools. Pre-service teachers stressing this idea believed that in order to follow and to adopt new technological developments, people should be scientifically literate, and chemistry helps to be scientifically literate; thus students in high schools should learn chemistry.

Finally, pre-service teachers stated that chemistry teaching is important in high schools in order to develop interest in chemistry. However, the percentage of pre-service teachers giving importance to developing interest in chemistry was much lower than other categories. Thus, it can be inferred that pre-service teachers that participated in the study do not consider affective domain very important. Using chemistry concepts in a cognitive framework is more important in their opinion.

As a global result of this study, we can state that the pre-service teachers thought that teaching chemistry is important in high schools. This finding is consistent with the finding of Bryan (2003) who studied with a prospective elementary teacher. In addition, Levitt (2001) supports the teachers' beliefs about the importance of science education in terms of fostering positive attitudes toward science. In the study of Van Driel, Bulte and Verloop (2005), it was found that chemistry teachers supported the curriculum which emphasized acquisition of fundamental concepts and skills in chemistry, and development of ability to make decisions about social issues involving chemistry. Considering these aspects, it can be said that the teachers give importance to chemistry teaching, which is consistent with the results of the present study.

In this study, pre-service teachers did not stress the importance of developing higher order abilities like critical thinking ability or problem solving ability. They didn't take developing interest in chemistry as a purpose of chemistry teaching into account too much, either. It can be thought that it is not surprising since secondary and university chemistry education use the traditional methods of teaching. This view of teaching and learning gives little importance to the improvement of scientific skills, for example. Therefore, the

majority of the pre-service teachers in this study may only have conceptualized the importance of teaching chemistry in daily life as a major reason to teach the discipline.

In the interviews, the origins of these thoughts were examined. It was observed that pre-service teachers' education life has a strong effect on having these beliefs since most of the pre-service teachers gave examples from their chemistry classes either in high school or university. Most of these pre-service teachers have been affected by their chemistry teachers and the way they explain the subject-matter. Chemistry classes have more effect than pedagogical classes on their beliefs about the importance of chemistry teaching. This result supports the finding of Tsai (2002) claiming that the reason for a teacher to hold a specific view on science might be due to the teachers' own school science experience and the science classes, laboratory works, or activities in their teacher education program.

Implications for Teacher Education

Beliefs are important indicator of a teacher's actions in a class (Bandura, 1986; Pajares, 1992; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998; Woolfolk Hoy, Davis, & Pape, 2006). It has been accepted that teachers' beliefs about teaching affect their instructional practice (Nespor, 1987; Pajares, 1992; Lederman, 1999). However, it should be mentioned that pre-service teachers do not enter teacher education programs without any beliefs about teaching. Pre-service teachers' personal experiences as learners in high schools are influential in shaping up their beliefs (Mellado, 1998; Southerland & Gess-Newsome, 1999; Tsai, 2002). Therefore, this study has several implications for teacher education. In teacher education programs, as a first step, pre-service teachers' prior beliefs should be made explicit by encouraging pre-service teachers discuss and reflect on their beliefs (Mellado, 1998; Southerland & Gess-Newsome, 1999; Bryan, 2003). As well as their previous learning experiences, courses in teacher education programs have an influence in the development of pre-service teachers' beliefs. Teacher education programs should stress the importance of chemistry teaching in high schools. The purposes of chemistry and how chemistry teaching fulfills these purposes, e.g. developing students' generic skills, curiosity or scientific literacy, should be discussed. Moreover, chemistry should be taught both in high schools and universities in a way which improves students' scientific skills such as critical thinking ability through problem-solving activities. Pre-service teachers should be also encouraged to teach chemistry bearing these purposes in mind during their school practice. In chemistry education, learning content and acquiring scientific skills cannot be separated from each other. As stated before, in the present study, most teachers pointed out understanding daily life as a major reason of teaching chemistry without considering the development of scientific skills in students. The researchers proposed as reason that pre-service teachers less experience in which they use their skills. Thus, teacher education programs have very important roles in developing scientific skills in pre-service teachers so that they become aware of the importance of these skills and try to improve their students' skills when they start teaching. In this sense, inquiry based teaching strategies are suggested to be effective (Brown & Melear, 2006;).

In addition, stress only on chemistry content in teacher education programs may prevent pre-service teachers understand nature of scientific knowledge. However, nature of science should be emphasized in teaching methods courses because understanding of nature of science would help pre-service teachers broaden their views of chemistry as well as teaching strategies.

This study contributes to the literature on teacher education by providing keys for understanding pre-service teachers' beliefs about chemistry teaching which are an important

element of their practice. Also, beliefs represent teachers' intentions to implement reform-based strategies (Haney, Czerniak & Lumpe, 1996). In recent years, science education reform describes the purpose of science education as enhancing students' critical thinking, problem-solving skills as well as their content knowledge. Haney and McArthur (2002) suggested investigation of teachers' belief structure from constructivist teaching perspective to guide change in science education. Since the present study gives an idea about pre-service teachers' beliefs about chemistry teaching in terms of developing scientific skills, one of the purpose of constructivism, it may help researchers and curriculum developers in designing curricular activities. For further study, it can be recommended that future investigation may focus on the possible influence of different experiences on prospective teachers' views about the importance of chemistry teaching.

References

Aguirre, J. M., Haggerty, S. M. & Linder, C. J. (1990). Student-teachers` conceptions of science, teaching and learning: a case study in preservice science education. *International Journal of Science Education,* 12, 381-390.

American Association for the Advancement of Science (AAAS). (1991). *Science for All Americans*. New York: Oxford University Press.

American Association for the Advancement of Science (AAAS). (1997). *Resources for Science Literacy.* New York: Oxford University Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Berkowitz, L. (1980). *A survey of social psychology.* New York: Holt, Rinehart and Winston.

Bogdan, R. C. & Biklen, S. K. (1998). *Qualitative research for education: an introduction to theory and methods.* Boston: Allyn and Bacon.

Briscoe, C. (1991). The dynamic interactions among beliefs, role metaphors and teaching practices. A case study of teacher change. *Science Education*, 75(2), 185-99.

Brown, S. L. & Melear, C. T. (2006).Investigation of secondary science teachers' beliefs and practices after authentic inquiry-based experiences *Journal of Research in Science Teaching, 43*(9), 938-962.

Bryan, L. A. & Abell, S. K. (1999). The development of profesional knowledge in learning to teach science. *Journal of Research in Science Teaching,* 36, 121-139.

Bryan, L. A. (2003). Nestedness of beliefs: examining a prospective elementary teacher's belief system about science teaching and learning. *Journal of Research in Science Teaching*, 40(9), 835-868.

Bryman, A., & Cramer, D. (1997). *Quantitative Data Analysis with SPSS for Windows: A Guide for Social Scientists.* London & New York: Routledge.

Chiappetta, E.L. & Koballa, T.R. (2002). *Science Instruction in the Middle and Secondary Schools.* New Jersey: Merril Prentice Hall.

Cronin-Jones, L.L. (1991). Science teaching beliefs and their influence on curriculum implementation: two case studies. *Journal of Research in Science Teaching,* 38 (3), 235-50.

Dillon, D. R., O`Brien, D. G., Moje, E. B. & Stewart, R. A. (1994). Literacy learning in secondary school science classrooms: a cross-case analysis of three qualitative studies. *Journal of Research in Science Teaching,* 31, 345-362.

Explanations of the factors in the dimensions of scientific literacy. (n.d.). Retrieved Februray 3, 2004, from http://www.sasked.gov.sk.ca/docs/physics/scilphyc.html

Fishbein, M. & Ajzen, I. (1975). *Belief, attitude, intention and behavior: an introduction to theory and research*. Reading, MA: Addison-Wesley.

Flick, U. (1998). *An Introduction to Qualitative Research.* London: SAGE.
Gess-Newsome, J. (1999). Teachers' knowledge and beliefs about subject matter and its impact on instruction. In J. Gess-Newsome & N.G. Lederman (eds.), *Examining Pedagogical Content Knowledge: The Construct and its Implication for Science Education*, (pp. 51–94), Dordrecht: Kluwer.
Green, T. (1971). *The activities of teaching*. New York: McGraw-Hill.
Gunstone, R. F., Slattery, M., Baird, J. R. & Northfield, J. R. (1993). A case study exploration of development in preservice science teachers. *Science Education,* 77, 47-73.
Haney, J. J., Czerniak, C. M., & Lumpe, A. T. (1996). Teacher beliefs and intentions regarding the implementation of science education reform strands. *Journal of Research in Science Teaching,* 33, 971-993.
Haney, J. J. & McArthur, J. (2002). Four case studies of prospective science teachers' beliefs concerning constructivist teaching practices. *Science Education,* 86, 783-802.
Hashweh, M.Z. (1996). Effects of science teachers' epistemological beliefs in teaching. *Journal of Research in Science Teaching,* 33, 47-63.
Hofer, B.K. & Pintrich, P.R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, 67, 88–140.
Kagan, D. M. (1992). Implications of research on teacher belief. *Educational Psychologist,* 27, 65-90.
King, K., Shumow, L. & Lietz, S. (2001). Science education in an urban elementary school: case studies of teacher beliefs and classroom practices. *Science Education,* 85, 89-110.
Lederman, N. G. (1999). Teachers' understanding of the nature of science and classroom practice: factors that facilitate or impede the relationship. *Journal of Research in Science Teaching*, 36(8), 916-929.
Levitt, K. E. (2001). An analysis of elementary teachers' beliefs regarding the teaching and learning of science. *Science Education*, 86, 1-22.
Mellado, V. (1998). The classroom practice of preservice teachers and their conceptions of teaching and learning science. *Science Education,* 82, 197-214.
Millar, R. & Osborne. J. (1998). *Beyond 2000: Science education for the future*. Retrieved February 3, 2004, from University of London, Department of Education and Professional Studies Web site: http://www.kcl.ac.uk/depsta/education/publications/be2000.pdf
Mitchener, C. P. & Anderson, R. D. (1989). Teachers` perspective: developing an implementing an STS curriculum. *Journal of Research in Science Teaching,* 26, 351-369.
Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies*, 19(4), 317-328.
Pajares, M. F. (1992). Teachers' beliefs and educational research: cleaning up a messy construct. *Review of Educational Research*, 62(3), 307-332.
Parkinson, J. (1994). *The Effective Teaching of Secondary Science,* London and New York: Longman.
Pintrich, P. R. (1990). Implications of psychological research on student learning and college teaching for teacher education. In Houston, W. R. (Ed.), Handbook of research on teacher education (pp. 826-857). New York: Macmillan.
Pomeroy, D. (1993). Implications of teachers' beliefs about the nature of science: comparison of the beliefs of scientists, secondary science teachers, and elementary teachers. *Science Education*, 77(3), 261-278.
Porlán, R. & Martín del Pozo, R. (2004). The conceptions of in-service and prospective primary school teachers about the teaching and learning of science. *Journal of Science Teacher Education*, 15(1), 39-62.
Ratcliffe, M. (1998). *ASE Guide to Secondary Science Education,* London: Stanley Thornes.

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In Sikula, J. (Eds.), *Handbook of research on teacher education*, (pp.102-119). New York: MacMillan.
Robson, C. (1993). *Real World Research: A Resource for Social Scientists and Practitioner Researchers*. Oxford: Blackwell.
Salmon, P. (1988). *Psychology for Teachers: An Alternative Approach,* London: Hutchinson.
Shrigley, R. L., Koballa, T.R. & Simpson, R. D. (1988). Defining attitude for science educators. *Journal of Research in Science Teaching*, 25(8), 659-678.
Smith, D. & Neale, D. (1991). The construction of subject matter knowledge in primary science teaching. In J. Brophy (Eds.), *Advances in research on teaching,* vol. 2 (pp187-243). Greenwich, CT: JAI Press.
Smith, M. U. & Siegel, H. (2004). Knowing, Believing, and Understanding: What Goals for Science Education? *Science & Education,* 13, 553-582.
Southerland, S. A. & Gess-Newsome, J. (1999). Preservice teachers` views of inclusive science teaching as shaped by images of teaching, learning, and knowledge. *Science Education,* 83, 131-150.
Spear, M. G. (1984). Sex bias in science teachers` ratings of work and pupil characteristics. *European Journal of Science Education,* 6, 369-377.
Tobin, K. & Espinet, M.(1989). Impediments to Change: Applications of Coaching in high school science teaching. *Journal of Research in Science Teaching,* 26 (2), 105-120.
Tsai, C. (2002). Nested epistemologies: science teachers' beliefs of teaching, learning and science. *International Journal of Science Education*, 24(8), 771-783.
Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68*, 202-248.
Van Driel, J.H., Bulte, A. M. W. & Verloop, N. (2005). The conceptions of chemistry teachers about teaching and learning in the context of a curriculum innovation. *International Journal of Science Education*, 27(3), 303-322.
Veal, W. R. (2004). Beliefs and knowledge in chemistry teacher development. *International Journal of Science Education,* 26(3), 329-351.
Wallace, J. & Louden, W. (1992). Science teaching and teachers` knowledge: prospects for reform of elementary classrooms. *Science Education,* 76, 507-521.
Wallace, C. S. & Kang, N. (2004). An investigation of experienced secondary science teachers' beliefs about inquiry: an explanation of competing belief sets. *Journal of Research in Science Teaching*, 41(9), 936-960.
Waters-Adams, S. (2006). The Relationship between understanding of the nature of science and practice: The influence of teachers' beliefs about education, teaching and learning. *International Journal of Science Education*, 28(8), 919-944.
Wellington, J. (2000). *Teaching and Learning Secondary Science: Contemporary Issues and Practical Approaches.* London and New York: Routledge.
Woolfolk Hoy, A., Davis, H., & Pape, S. (2006). Teachers' knowledge, beliefs, and thinking. In P. A. Alexander & P. H, Winne (Eds.), *Handbook of educational psychology* (2nd ed., pp. 715-737). Mahwah, NJ: Lawrence Erlbaum.
YÖK (2000) *Selection and Placement of Students in Higher Education Institutions in Turkey,* Retrieved 2003, from http://www.osym.gov.tr/eng/index.html.